Application of Caspers et al.
Attorney Docket No. 4000-7742
February 28, 2005

ENGLISH TRANSLATION OF PCT APPLICATION

Title: Plain Bearing Shell and Method for Producing a Holding Projection of a Plain Bearing Shell

Description

The invention relates to a plain bearing shell for supporting a crankshaft or a camshaft, or as a connecting rod bearing shell of an engine, said plain bearing shell comprising a radially outward protruding holding projection in the region of the separating surface of the plain bearing shell.

An approach that has been known and commonly employed for some time involves forming radially outward protruding holding projections or cams in the region of the separating surfaces of crankshaft plain bearing shells used in internal combustion engines. They serve first of all as an installation aid that enables the plain bearing shells to be correctly positioned and installed in the engine block. However, they also prevent the plain bearing shells from twisting in the installed position during engine operation, either in a circumferential or axial direction.

An approach that has been known for some time involves using a stamping tool to form the holding projections in the region of the separating surfaces in the form of radially outward protruding release openings, said stamping tool being applied radially inward, that is, in the direction from the sliding surface of the plain bearing shell. However, this method of forming the holding projections has proven to be disadvantageous in that, in the region of the sliding surface or support surface, an opening facing the separating surface is created which has sharp edges that must then be rounded off by an elaborate process, and that in any case create a gap in the sliding surface.

DE 32 30 700 C 2 has already put forward the proposal to create the holding projection without forming a gap in the sliding surface, that is, without affecting the sliding surface, by an approach in which the associated separating surface of the plain bearing shell is compressed in a radially and axially delimited region such that, with an appropriate counter-holding action, material is deformed radially outward from the inner sliding surface, thereby forming the holding projection. It is of course understood here that the bearing shell must also be supported in the region of its outer side by an appropriate tool. In plain bearing shells with a holding projection

produced in this manner, the compressed surface of the holding projection is necessarily situated lower than the associated separating surface of the plain bearing shell. In addition, the total projection is lower, that is, further removed from the plane of the associated separating surface than is the case, for example, in the method referred to above. This means that the bearing shell receptacle, for which of course a recess matching the projection must be provided, must undergo more elaborate and expensive machining, that is, in order to achieve greater depth. For this purpose, so-called side-milling cutters must be employed which, due to the requisite greater depth of formation of the recess for the bearing receptacle, must be of larger size and work at greater depth. In addition, a plain bearing shell of this type proves to be disadvantageous during assembly since the lower-lying holding projection relative to the separating surfaces of the plain bearing shell is not easily visible when the one views the separating surface, or, depending on the orientation, is itself not visible at all. The plain bearing shell must be rotated by hand and oriented so as to make the position of the holding projection discernible.

Starting from the above conditions, the objective on which the present invention is based consists in creating a plain bearing shell of the species which can be produced economically, in which the radial inner sliding surface is not affected during production, and in which the disadvantages described above do not occur.

According to the invention, this objective is achieved by a plain bearing shell which is characterized in that the holding projection merges continuously into the separating surface of the bearing shell and is formed from the outside of the plain bearing shell using a stamping tool by an approach in which, in the region of the separating surface, the stamping tool compressively deforms the material on the outside of the plain bearing shell essentially tangentially relative to the plain bearing shell and in the direction of the separating surface, while a counter-holding means is applied to the separating surface, to which means the formed material of the holding projection extends.

The invention thus proposes to form the holding projection such that one surface of it lies in a plane of the associated separating surface, that is, is not lower than this surface. The result of this approach is that the material is all but deformed from the opposite direction against the separating surface. To this end, a stamping tool is moved essentially perpendicularly to the separating surface, which is equivalent to moving essentially tangentially relative to the outside of the plain bearing shell in the direction of the separating surface, specifically, so that the

stamping tool grazes the outside of the plain bearing shell in the region of the separating surfaces in such a way that material is displaced in the direction of the separating surfaces and radially outward. The material is compressed in such a way that it extends up to the counter-holding means. The flow of the material can also be restricted in the axial direction by appropriately shaping the tool.

It has proven to be advantageous to have the holding projection extend radially approximately 0.5-2 mm, specifically, 0.7-1.7 mm beyond the outside of the plain bearing shell.

In addition, the subject of the invention is a method for producing a holding projection protruding radially outward for a plain bearing shell, said method according to the invention having the features of Claim 3.

Additional features, details, and advantages of the invention are found in the drawing and following description of a preferred embodiment of the plain bearing shell according to the invention, and description of the method for producing the holding projection.

Figure 1 is a diagram showing part of a previously known plain bearing shell;

Figure 2 is a diagram showing part of a plain bearing shell according to the invention;

Figure 3 is a top view of the separating surface of the plain bearing shell in Figure 2.

Figures 4-6 illustrate the process for producing the plain bearing shell.

Figure 1 is a diagram showing part of a plain bearing shell 2 comprising a radial holding projection 4 and a bearing receptacle 6 with a recess 8 which holding projection 4 engages. Holding projection 4 is formed by a process in which pressure has been applied in the direction of arrow 10, that is, essentially perpendicularly to the separating surface 12 of plain bearing shell 2, and material has then essentially been displaced in the direction of arrow 10, thereby forming holding projection 4. It is evident that one surface 14 of holding projection 4 is situated "deeper" than the associated separating surface 12 of plain bearing shell 2. Accordingly, recess 8 of bearing receptacle 6 must be worked so as to project further, that is, also be "lower."

Figure 2 finally shows a plain bearing shell 20 according to the invention, also illustrated in a partial schematic diagram, but without the bearing shell receptacle and with counter-holding means to be explained in more detail below. Plain bearing shell 20 has a steel support layer 22 as well as a bearing metal layer 24 which may be applied in any fashion, but especially by plating or casting. The bearing shell may also, however, be formed as a solid material. A radially outward protruding holding projection 26 is evident which, at its surface 28 facing the separating

surface, merges continuously into the separating surface 30 of plain bearing shell 20. Surface 28 of projection 26 thus lies within the surface or plane of separating surface 30.

Figure 2 shows a counter-holding means 32 which is applied against separating surface 30 and extends at least radially beyond separating surface 30. In addition, a counter-holding means 34 is shown which matches the interior contour of plain bearing shell 20. In addition, a stamping tool 36 is shown (schematically) which is movable in the direction of the arrow 38 towards counter-holding means 32, and thus essentially perpendicularly to separating surface 30 or essentially tangentially relative to plain bearing shell 20. The above references to "essentially perpendicularly" or "essentially tangentially" must be understood to subsume specifically ±15° of orientation within this concept, whereby what is ultimately intended to be expressed is that stamping tool 36 is moved towards separating surface 30 and counter-holding means 32 in such a way that material on the outside of support layer 22 is displaced both toward separating surface 32 and radially outward to form holding projection 26. For this purpose, stamping tool 36 preferably has a sharp cutting edge 40 in order to slightly penetrate the surface of the outside of support layer 22. The resulting effect is to displace material in the direction of arrow 42 to form projection 26. Arrow 42 is intended to illustrate the displacement of material both towards separating surface 30 and radially outward.

Plain bearing shell 20 according to the invention proves to be advantageous in that holding projection 26 is able to be recognized visually by merely glancing at associated separating surface 30 of plain bearing shell 20. The result is that assembly of the plain bearing shell is simplified, and a complementary recess in the region of the bearing receptacle does not have to have as deep a form.

Finally, Figure 3 provides a top view of separating surface 30 of plain bearing shell 20. It is evident that holding projection 26 extends radially beyond a depth T of 0.8-1.6 mm beyond the outside of plain bearing shell 20. The thickness of the plain bearing shell may be between 1.4 and 5 mm.

Figures 4-6 illustrate the production process in which stamping tool 36 is moved such that it engages the outside of the plain bearing shell approximately in a circumferential direction and tangentially.